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STUDY OF ELECTRONIC LEVEL MONITORING SYSTEM FOR EMERGENCY POWER SUPPLY TRAILER IN REMOTE AREA

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ABSTRACT

This research focuses on the development and manufacture of electron level controlling system in towering emergency power supply car organization, with a purpose to detect the instant break in declivity of the carrier in hanging state or in transporting state. By employing single chip micro-controller, inertial measurement unit and three-axis gyroscope sensor in the carrier platform, the instant change data of X, Y and Z axes could be sent to the computer end. The sensor interpretation will send the instant state information of the carrier to the client side. The instant horizontal position information of the user serves as the basis of adjustment in increasing the adaptability of the chassis to the ground and reducing shake and jolt of car body; provides device security and stability. The research is proved to be truly feasible with experiments.

KEYWORD: Electronic Level, Microprocessor, Gyroscope

INTRODUCTION

Greenhouse effect and climatic change of weather are causing a huge impact on the environment. Energy shortage and global warming have been human crisis due to the industrial revolution. To maintain the sustainable development of our planet, it is necessary and preferable to make the research and development of industries energy saving and low carbon-oriented [1-7]. The dramatic change of the global climate results in disasters around the world, which cause severe damage and casualties. Relief operations must be done at full speed after the disaster. Electric power supply is not easy in bad environmental conditions, in which only the green power is available. It is an important project of how to send the emergent power supply system to the disaster area or remote area when facing traffic and electricity interruption situation. There are two points described in the following subsections.

Emergent power supply trailer which can be hanged and is good in shock absorption function meets the demand. The invention of towering emergency electricity trailer makes it available to send electricity power system to disaster area or remote area. Given the energy need in disaster relief in remote area, this research focuses on development of supplementary type mains supply trailer available for helicopter or vehicle, that is, combined battery groove energy storage system. Taking mains supply, engine-type generator, wind energy, water power, solar power and fuel cell and battery hybrid energy as the emergency power source is necessary for night lighting and mobile electric vehicle.

As the research focuses on designing and studying electric level control in emergency power supply trailer which is available for both helicopter and vehicle and uses combined mains supply and engine-type generator, the main structure design of the machine must be available for both hanging operation and vehicle dragging function. Instant horizontal information is also necessary for achieving best shock-proof effect and ensuring its security and stability as shown in figure 1.

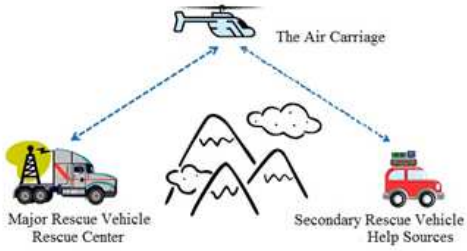


Figure 1: Emergent Power Supply Trailer System

SYSTEM DESIGN

The mathematic model [8] is made according to the development physical system of vibration and applies related vibration rules and vibration suppression technique to the engineer anti-vibration design [9-15]. It plays an especially important part in combination [16-17] and vibration damping technique [18-21] for active vibration suppression rule, which can be used in the anti-vibration design in sea and air vehicle to effectively absorb disturbance caused by rough road situation. It will reduce influence of disturbance energy on the vehicle, which proves that related technology worth developing.

In designing the electronic level control system of anti-vibration and vibration reduction system, this research instantly adjusts level condition of each wheel to make it possess the vibration reduction efficiency used in bearing kinetic energy (K. E) from vertical direction and at the same time able to absorb vibration in rough road situation. The design aims at guaranteeing that the overall framework of trailer receives no damage in landing and increasing the comfort level and safety.

Firstly the research analyzes the device and controlling circuit configuration of the vehicle's framework. Make design drawing with painting software referring to the actual size of the device and then conduct element analysis, manufacture, composition and test with simulation software to complete the body framework of the trailer. Balance structure design is done after this. Making dynamic simulation analysis with the help of software to find out the parameter change that influences the performance, which is serves as the reference on electron level control system development. Procedure mentioned above aims at avoiding damper explosion when the trailer is traveling and landing to reduce damage and keep device and staff safe.

According to the parameter and information mentioned above, this research adopts single crystal micro-controller, inertia sensor and serial information transfer system as the research equipment on considering the cost and technology integration. The attributes are stated as follows [22] [23]:

Microprocessor

Ardinuo is the microprocessor for open software and hardware source code. Program of the software is available in the network and its circuit design drawing can be downloading from the official website and adjusted according to your demand. But it should be in accordance with the CC license terms (creation CC license terms).

Ardinuo is much easier and more in reference data compared with common microprocessor. Developers need to have a good command in both electron and electric machine skills like writing program, designing circuit and doing logical

calculus in order to develop microprocessor program in hardware. Based on open network sharing, users in Arduino share products and make change in program and circuit to complete an overall system that suits their demand in a short time.

Arduino is mainly divided into hardware, software and expansion element. Ready-made expansion board or assembled circuits with electron materials serve as the hardware. Software is able in Serial communication, external interruption, PWM pulse width adjustment, serial transmission (SPI) and I²C data transmission, etc.

Inertia Sensor

Inertial Measurement Unit (IMU) refers to combining product through 6 axis or 9 axis of the sensor set. The sensor can be used as an application or system by combining individual censor data with micro-controller. The combination reduces errors that might exist in individual sensor thus to figure out accurate position and direction.

The IMU can be used to measure accelerated speed and angular speed of an object in movement and the data measured is useful in building X, Y and Z coordinate. IMU is usually equipped in the center of the object to make the date more accurate.

Serial Transmission

It is one of the methods to transmit data between CPU and other devices or CPU and CPU. The simplest transmission asks for only two transmission wires. It transmits one BIT data in one time and it is preferable for its fewer transmission wire requirement and it is safe from noise interruption, which is suitable for long-distance transmission. But it is weak in transmission speed. Though it is simple in framework, it needs communication protocol to solve the problems caused by too much simplicity. Asynchronous serial transmission is often applied to serial transmission. It works by adding one beginning BIT before transmitting 8 BIT data and one end BIT after the transmission to reduce the error rate of transmission, which adds up the total transmission BIT to 10. Details are shown in figure 2 (texts in it are: Wait for beginning BIT change, Beginning BIT, End BIT, Data signal).

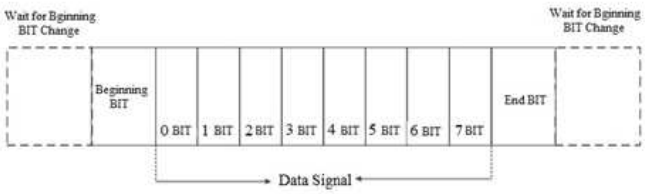


Figure 2: Sketch Map of Data Transmission

Beginning BIT is low potential 0 and end BIT is high potential 1 and receiving end keeps checking data transmission in asynchronous serial transmission. It means no transmission data when data signal remains 1; when it turns into 0, it means data is going to be transmitted and receiving end is ready to receive 8 BIT data. The transmission end will send end BIT after the transmission and keep the signal as 1 to wait for next transmission. It reduces transmission efficiency but solve problems happen during the beginning and end of the transmission.

Another serial transmission protocol is the transmission speed, which is often measured by Buat Rate, the signal changing rate of the transmission wire each second, that is, transmission BIT each second. Buat Rate used in asynchronous serial transmission are usually 1200, 2400, 4800 and 9600 and the maximum could be 115200 bps. Buat Rate should be decided before conducting serial transmission and the rate of the two devices used in transmission should be the same to

guarantee correct transmission data.

RESEARCH STRUCTURE

System Procedure

The procedure in this research starts with setting variate, time and external interruption to make sure whether the sensor works well; if it does not, wait for connection sensor, if it does, make sure the transmission works well and correctness of data; if the data is incorrect, adjust the connection parameter and move to next step when confirm the correctness. The sensor receives instant data and sends it to computer end for the user and the user should decide whether to end the procedure or not. Figure 3 is the procedure map of design in this research.

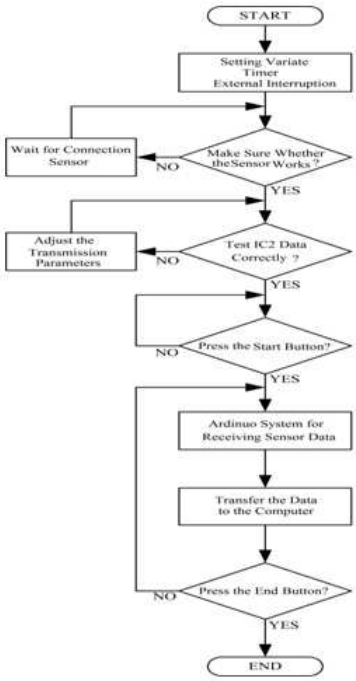


Figure 3: Procedure of the Design

System Structure

Figure 4 shows system framework of this research, which is the towering emergency trailer that combines various emergency electric generator, ATS, automatic rising-lowering and energy. Anti-vibration unit of the vehicle adopts Ardinuo and three-axis gyroscope sensor to record instant data in X, Y and Z coordinate. Condition of the carrier could be known by sending data to the computer through I2C data transmission and interpreting condition of the sensor. The system could also automatically adjust the level.

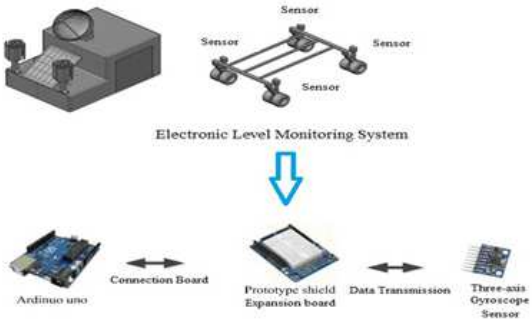


Figure 4: System Structure

Controlling Strategy

The micro-controller Arduino applied by this research is a 16 BIT, 5V voltage and with a frequency of 20 MHz under maximum system resolution. By using the I²C data transmission, timer and external function, the data that sensor detected are sent to the micro-controller. Buat Rate of the controller chooses 11520 bps, which makes the transmission fastest in speed to achieve real-time monitoring.

I²C Data Transmission

I²C uses only two bidirectional signal wires, that is, serial data line(SDA) and serial clock line (SCL) and uses resistance to adjust system potential. I²C allows a fairly wide working voltage range and normal working voltage is +3.3V or +5V.

Addressing in I²C design can be divided into 10-BIT long addressing and 7-BIT short addressing and the long one allows 1,024 crystals and short one allows 128 crystals in a same I²C-bus. According to different transmission rates, bus-bar of common I²C is divided into standard mode (100Kbit/s), lows-speed mode (10Kbit/s) and rapid mode (400Kbit/s). Its clock rate frequency is allowed to be reduced to 0, which means the communication is suspended. Latest I²C bus-bar is available for making communication with more nodes (addressing space that supports 10 BIT length) at a faster speed-high speed mode (3.4 Mbit/s).

I²C has only two lines in hardware connection: SDA (Serial Data Line) and SLC (Serial Clock Line). All device merge in those two lines and all connect with open drain's I/O connection tub, which means the switch in the connection tub is grounded low potential when connection is smooth and suspension joint of broken line when it is not in conducting state. However, I²C asks for real logic high potential, so the research puts pull-high resister in both SDA and SCL to make the line lie in logic high potential state when it is not in conducting state.

Circuit Structure

Figure 5 shows the circuit structure of this research. The Ardinuo works together with three-axis gyroscope sensor MPU6050 to transmit real-time data in X, Y and Z axis. The I²C then transmits the data to micro-controller to make it available in computer end.

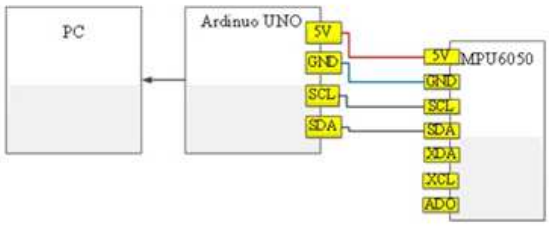


Figure 5: Circuit Structure

EXPERIMENTAL RESULTS

Figure 6 is the entity of the design and there are Ardinuo UNO control panel, Prototype shield expansion panel and three-axis gyroscope sensor MPU6050. Button in the expansion panel start/end the operation and the LED units make sure the correct operation of the sensor.

Figure 7 shows entity of the three-axis gyroscope sensor used in this research and table 1 show its foot position. It transforms information of an object into data for X, Y and Z axis to confirm state of the object. The sensor is equipped in the center of the carrier to make the data more accurate. Buat rate used in this research is 115200bps.

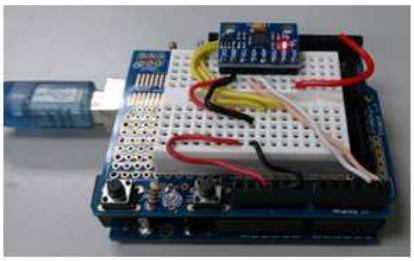


Figure 6: Entity of Circuit Panel **Figure 7: Entity of the Sensor**

Table 1: Foot Position of the Sensor

PIN1	VCC
PIN2	GND
PIN3	SCL
PIN4	SDA
PIN5	XDA
PIN6	SCL
PIN7	ADO
PIN8	INT

Figure 8 shows the procedure in making sure the connection of all elements and correctness of data in I²C transmission. After confirming its correctness by software, the button in the expansion panel is controlled to transmit data in gyroscope to the computer end.

Figure 9 shows data that the computer receives in the sequence of Z axis, Y axis and X axis. The sensor is making a periodic detection, so the bottom data is the latest gyroscope data. It can be known from the latest data whether the carrier is in horizontal state and the waggle range of the carrier and road situation in movement can also be known by comparing with data before.

Figure 8: Computer Start Interface

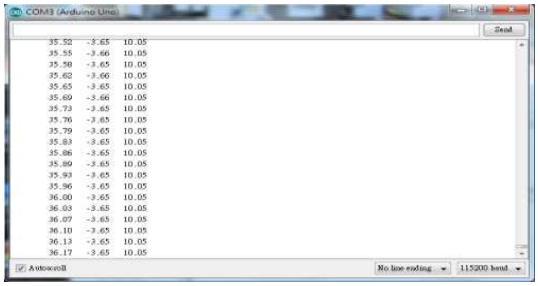
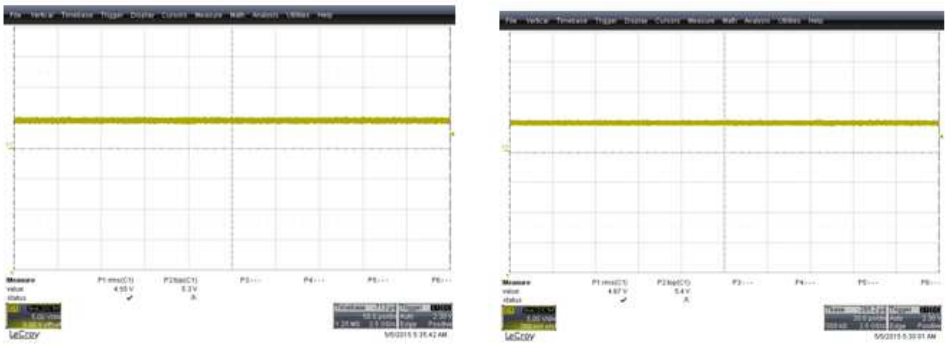


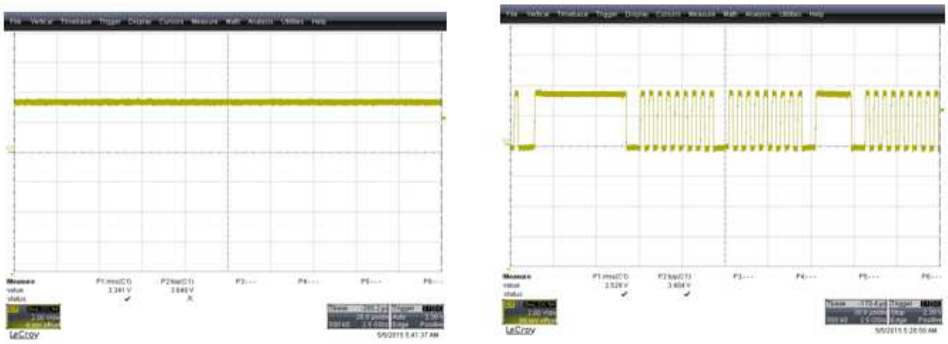
Figure 9: Data in Computer

Voltage of foot VCC before the system starts is 4.55V and 4.67V after the system starts, as shown in figure 10. Foot SCL is high level before the system startsand its foot position waveform after the system starts is shown in figure 11. Foot SDA is high level before the system starts and its foot position waveform after the system starts is shown in figure 12.



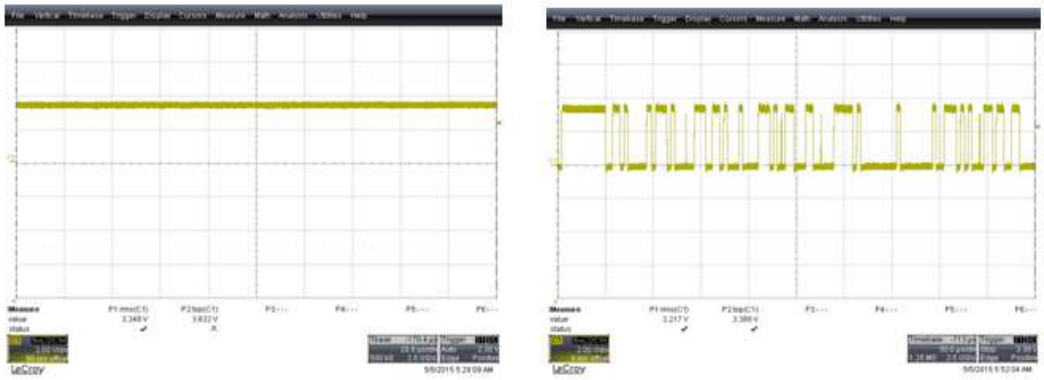
(a) Before (b) After

Figure 10: The VCC Voltage in the System



(a) Before (b)After

Figure 11: The SCL in the System



(a) Before (b)After

Figure 12: The SDA in the System

CONCLUSIONS

Gyroscope device was widely used in measuring the traveling state and speed in air and sea vehicles. The device has now been replaced by electric one. By using three-axis gyroscope sensor MPU6050 and micro-controller Arduino as the device to receive and transmit data, the balance state of carrier can be effectively known. The rate of Arduino could reach 115200 Buat Rate when using I²C to receive and transmit data, with 8.86μs for each bit. The precision of inclination angle could reach 0.01 degree, which makes the real-time monitoring possible. Equip the sensor circuit in the trailer to judge the state of the carrier through computer and control the hanging system of the carrier to keep the platform stable.

This research aims at studying and developing electricity trailer with combined mains supply electricity and is suitable for helicopter and dragging. By analyzing the framework, integrating function and attribute, accomplishing various parameter design and demand, this research modifies, designs and manufactures the required framework. In the electronic level control of the vibration suspension system, the system equips four-wheel suspension structure in the under-pan, which could automatically adjust with the change of road situation to increase grounded adaptability and reduce shock of the carrier. Security and stability of the complete device is improved with the design. The design is suitable for different occasions and environment and it is convenient for the user. Meanwhile, it guarantees the safety of both the machine and operators.

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